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# Characterisation of Soil Profiles on Four AFLQ Premier League Sporting Fields

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## Introduction

The AFLQ is focused on improving the quality of its Premier League sporting fields with a view to reducing the risk of player injury. To enable the identification of appropriate soil and irrigation management treatments to improve the performance of these surfaces, an initial field sampling program was undertaken in December 2003 to characterise the soil profile material present on four of the AFLQ Premier League sporting fields.

## Materials and Methods

### *Field sites*

The four AFLQ fields involved in the characterisation study were selected on the basis that they represented the full range of existing quality of playing surfaces within the AFLQ Premier League competition (Table 1). Soil profile core samples and surface measurements were obtained at four locations in each field representing various levels of training and playing intensity. The sites sampled and measured on each field were typically representative of the: outside flank area (low traffic/wear) training areas (intermediate-high traffic area, usually on flank near the club house); centre square area (intermediate-high traffic/wear), and goal mouth (high traffic/wear).

**Table 1. Perceived playing surface quality of the selected AFLQ fields**

| Field | Perceived quality of playing surface [1] |
|---|---|
| Morningside | Good |
| Sherwood | Acceptable |
| Everton Park | Acceptable |
| Zillmere | Below average |

[1] as assessed by AFLQ ground staff

### *Soil Profile Cores*

Soil profiles were sampled to a depth of 500 mm using a 3 tonne hydraulic Mole Rig fitted with a 100 mm diameter push tube (Figure 1). Four cores were sampled at each one of four locations with the field. The cores were extracted from the push tube, photographed and placed in a protective PVC pipe for transport. Individual soil horizons in each core were identified on the basis of soil colour, texture and density differences. A sample of each horizon was then passed through a 2 mm sieve to separate and quantify the fraction of coarse fragments and soil material. The colour, texture and pH of the soil material in each horizon was then described using the methods outlined in McDonald et al. (1990).


**Figure 1. Mole rig extracting 100 mm diameter soil cores from sporting fields**

### *Surface Measurements*

Measurements of the soil surface roughness, bulk density, moisture content and penetration resistance were taken at each of the four sampling locations on each field. Photographs of the representative grass cover were also taken at each location. Surface roughness was measured using a Rimik Profilemeter (Figure 2) with a 1 m frame width which contains 32 steel rods (5 mm diam) at 30 mm spacings. The rods were lowered onto the soil surface and individual rod height relative to the frame recorded by datalogger. Ten surface roughness profiles were sampled at each location in the field. While it is possible to present the surface roughness using a variety of indices, the average difference between the adjacent rods was chosen as it most appropriately represents the physical roughness over the scale which would influence both ball bounce and foot stability. Surface hardness was measured using a Geotester pocket penetrometer (Figure 3) fitted with a 60 degree cone tip (2.5, 3.5 or 4.5 mm diam). The cone was inserted by hand into the soil surface to a depth of 40-50 mm and the maximum penetration resistance measured. Twenty penetrometer measurements were taken at each of the four sampling locations in each field. Up to four core samples (48 mm diam) of the surface 0-50 mm layer were extracted using a sampling tube with cutting edge (Figure 4). These surface samples were subsequently used to obtain bulk density measurements and the soil moisture content at sampling.

**Figure 2. Rimik profilemeter for measuring surface roughness**

**Figure 3. Penetrometer resistance measured using a Geotester pocket penetrometer**

**Figure 4. Bulk density sampling of the 0-50 mm surface layer**

***Hydraulic modelling of soil-water movement***

Simulation modelling was used to conduct a preliminary evaluation of potential differences in soil-water movement associated with differences in the soil profiles found both across and between the fields. The model Hydrus-2D (Simunek *et al*. 1999) was parameterised using the measured textural properties of the soil cores and used to simulate the water movement within each soil profile (Figure 5) when either 25 mm of water is applied (eg typical of an irrigation event) or 60 mm of water is applied (eg. similar to a reasonable rainfall event). In both cases, the soil profile was assumed to be uniformly dry prior to the application of the water and there was no allowance for lateral soil-water movement. A range of additional soil physical measurements are currently being undertaken on the soil profile cores. This work will provide improved characterisation of the saturated hydraulic conductivity, air filled porosity and soil-water characteristic curve for the surface and other major horizons. This data will be used to improve the parameterisation of the soil-water model in an effort to more accurately predict the influence of both irrigation management alternatives and soil amendment options.

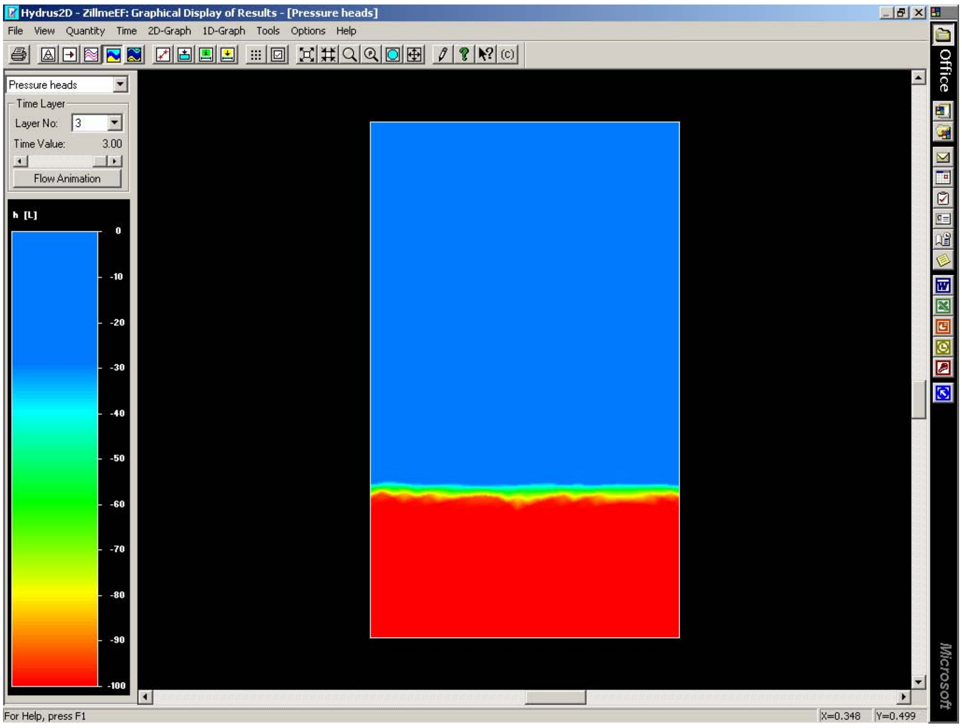



**Figure 5. Hydrus-2D Simulation screen used to evaluate soil-water movement through the soil profiles.**

## Results and Discussion

Significant differences in both grass cover and soil profile were found both between each of the fields and within each of the fields. Soil information sheets were produced for each of the four sampling sites on each of the four fields. These sheets (Appendix 1) include a photograph of the surface grass cover taken at the time of sampling, the full soil profile description aligned with a photograph of the soil profile core, and the results of the simulation modelling for the two alternative wetting events.

### *Everton*

The Everton field shows a clear difference in soil geomorphology across the field. The south-western side of the field near the club house has been produced by cutting down into the bedrock with mixing with either local or imported clay fill material. However, the north-eastern side of the field has been produced by levelling the lighter textured alluvial soil material associated with the local creek. The cricket pitch on this field has been constructed out of approximately 200 mm heavy clay overlying approximately 300 mm of 10-20 mm coarse gravel.

### *Morningside*

There is a high degree of horizontal layering present in each of the soil cores taken across this field. In general, the surface 200-300 mm material is composed of up to 4 different layers of sandy loam to sandy clay loam material. At each site across the field, there is a significant subsoil layer of light to heavy clay which could be expected to impede both soil-water movement and root growth. However, the depth and thickness of this layer was variable with the layer extending below 200 mm in the southern goal mouth and south-western flank area but not found until approximately 360 mm in the north-eastern flank area. The north-eastern flank area also has a layer of coarse fragments intermixed with the soil material extending between approximately 100 and 300 mm depth which could be expected to improve the drainage in this area of the field. The centre square core sampling was taken beside the cricket pitch at this field and the cores recorded show the edge of the clay pitch extending through at a depth of 200-300 mm. On the day of sampling, a free standing water table was found at a depth of approximately 400 mm on the north-eastern flank possibly reflecting the lateral movement of water in the 100-400 mm horizons.

***Zillmere***

The surface soil material across this field ranged from a sandy loam to a sandy clay loam. The depth of the surface material ranged from 140-230 mm and was typically laid over a 50 mm medium to heavy clay layer. The variability of the depth to the clay and coarse fill layer is likely to influence the effective rooting depth of the grass and influence its ability to access both nutrients and water. Mottling was found within the 300-500 mm subsoil clay layers suggesting that internal drainage of soils at this field may be problematic. A thick layer of coarse fill material (ash) was found at 290-500 mm on the south-western flank area. However, this fill material horizon was only approximately 50–80 mm thick in the other areas of the field and was found at a depth of approximately 300 mm in the centre square area, 200 mm in the north-east flank area, and approximately 150 mm in the southern goal square area. Some coarse brick material was found intermixed in the 160-310 mm depth at the southern goal square area. The centre square samples were not taken on the cricket pitch at this site.

***Sherwood***

The differences in the soil profiles across this field reflect the differences in elevation and the ability of the operators to accurately apply the requisite thickness of each layer during construction. There is a layer of coarse fill material in the subsoil of this field but the depth and thickness of this layer varies with location. The south-western flank of this field has a shallow layer (approximately 100 mm) of sand and sandy loam material overlying a thin horizon of light clay (100-130 mm) with the remainder of the profile consisting of the fill material. The surface (0-170 mm) layer of the southern goal mouth area is dominated by a light clay soil with the coarse fill material extending below a depth of approximately 300 mm. The north-eastern flank has approximately 60 mm of sandy loam overlying clay material which extends to a depth of approximately 250 mm where there is a layer of the coarse fill material approximately 50-150 mm thick. The centre of the field is underlain by a heavy clay cricket pitch at a depth of approximately 200-450 mm. This surface above the clay layer is composed of loamy sand to sandy clay loam horizons which show no evidence of water logging. This suggests that water does not pond above the clay layer but instead drains laterally off the clay layer upper boundary.

***Comparison of simulated soil-water movement studies***

The simulated soil-water movement for both the 25 mm and 60 mm water application are shown on the information sheets for each soil profile at each field (Appendix 1). The results highlight the significant variations that could be expected in irrigation performance and utilisation of rainfall as a consequence of soil-water holding capacity, effective rooting depths and internal drainage rates. In general, the application of 25 mm of water (eg typical irrigation) would result in the wetting of between 130 and 200 mm of soil. Only the eastern flank area of Sherwood exhibited any signs of transient waterlogging with the root zone due to the application of this volume of water. However, where larger volumes of water (eg 60 mm) are applied by either irrigation or rainfall, then the depth of wetting was found to range from 350 to 500+ mm with significant transient waterlogging in some areas of both Sherwood and Everton fields. Transient waterlogging would be expected to affect root growth, grass disease susceptibility and nutrient availability.

***Comparison of field surface measurements***

The physical properties of the surface 0-50 mm soil layer varied significantly both between the four fields and across the individual fields. The clay content of the surface soil on the sampled fields varied from 5 to 70 %. Similarly, the bulk density of the surface soil ranged from 1.1 to 1.7 g $cm^{-3}$ (Figure 6) and the penetrometer resistance ranged from 2.7 to 7.1 MPa (Figure 7). A significant ($P$<0.1) positive relationship was identified between penetrometer resistance and bulk density (Figure 8). Sherwood was found to have the highest bulk densities and penetrometer resistances of the fields measured. There was no significant difference between the average penetrometer resistances measured on the other fields. However, within individual fields, there was a wide range of both penetrometer resistance and bulk density. The penetrometer resistance was found to be consistently lower in the low traffic/wear areas associated with the outer flanks at each field site. There was typically no significant ($P$<0.05) difference in penetrometer and bulk density measurements taken in the intermediate-high wear areas on each field.

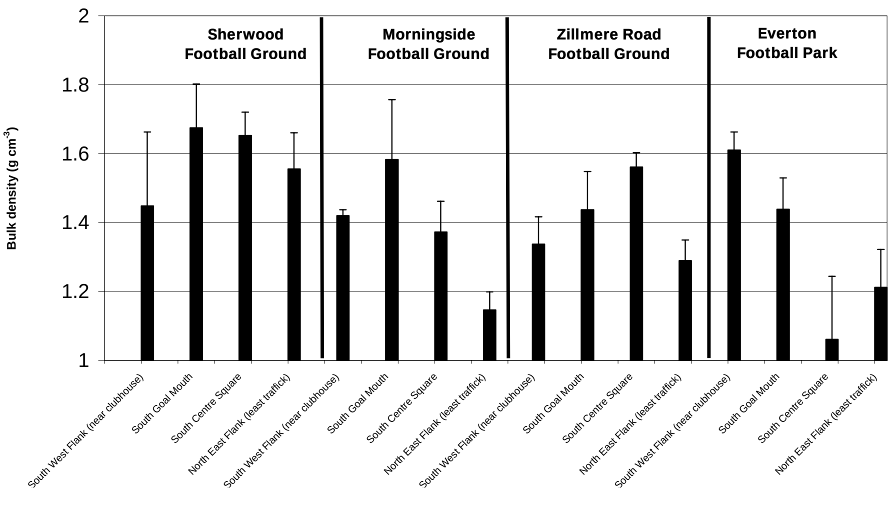



**Figure 6. Bulk density of surface 0-50 mm on four sporting fields.**

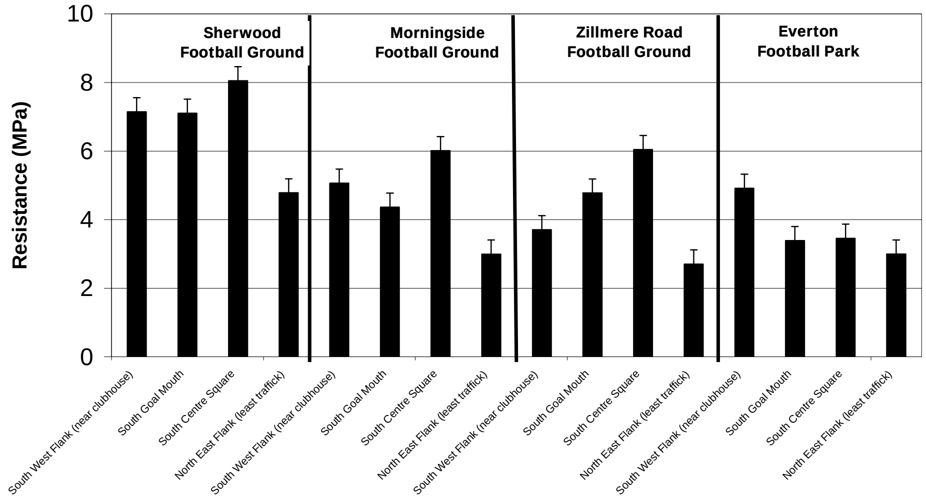



**Figure 7. Maximum penetrometer resistance of surface 0-50 mm on four sporting fields.**

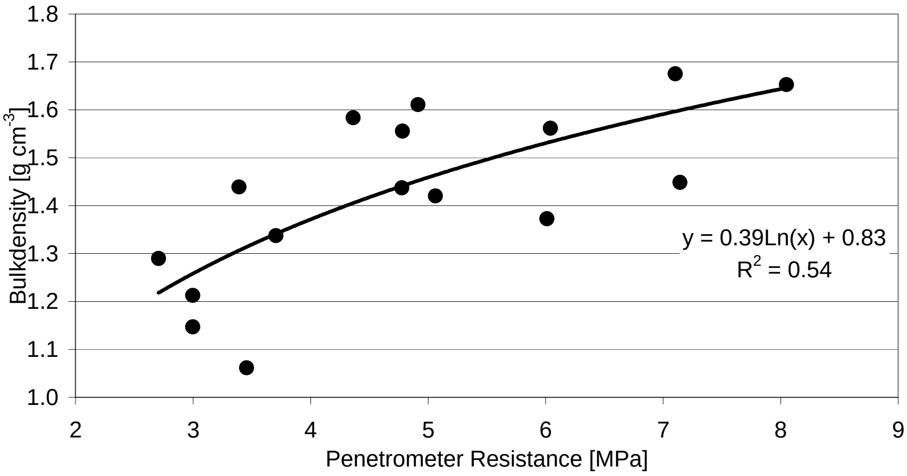



**Figure 8. Relationship between bulk density and penetrometer resistance**

Despite widespread and relatively consistent rain across each of the fields approximately five days before sampling, the volumetric moisture content of the surface soil on the day of sampling ranged from 18 to 48% (Figure 9). Differences in moisture content across the fields would be expected to reflect the variation in soil texture, depth to various restricting layers and compaction of the surface layers. For example, the high moisture content measured in the Everton centre square area is due to the high clay content of this material while the high moisture content measured in the north-east flank area of Morningside is likely to be related to the shallow watertable observed at this site during sampling. A significant ($P$<0.1) inverse relationship was found also between water content and bulk density. However, it is not clear from the current data whether this relationship was found because of differences in texture (ie lighter textured soil will have low water holding capacity but pack to high densities) across the sites or differences in compaction (ie. compacting soil will reduce the volume of pore space and water holding capacity). Hence, further work is required to identify the exact nature of relationship in this case.

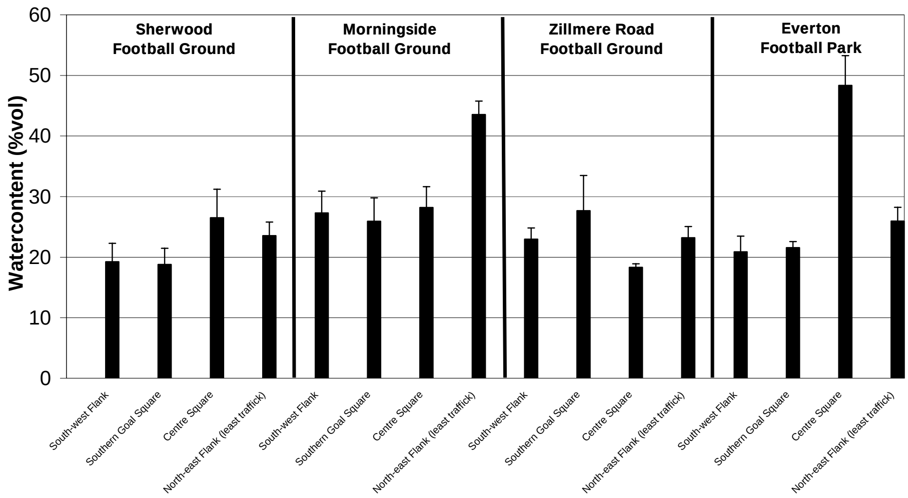



**Figure 9. Volumetric water content of surface 0-50 mm at time of sampling**

The roughness of the field surface was found to vary both between the fields and within the fields (Figure 10). Sherwood was found to have the highest average roughness of 5.2 mm (per 30 mm spacing) compared with 4.4 mm for Zillmere and 3.7 mm for Morningside. No data was obtained for the Everton field due to a malfunction of the equipment. Measurements of surface roughness on elite fields have been found to typically range between 2 and 4 mm. For Sherwood and Morningside, surface roughness was found to be higher in the low traffic/wear flank areas than in the higher wear areas. This may be due to a combination of both increased grass cover and grass height in these areas. For example, high traffic/wear areas which have low grass cover and smooth worn surfaces would be expected to have low surface roughness. Similarly, an area with a high grass coverage and a low grass height would be also be expected to have a low surface roughness. However, in areas with high grass cover where the grass is cut higher, there would be an expectation that the roughness would increase. Hence, the surface roughness as measured using the Profilemeter appears to be a function of grass type, percentage of grass cover, grass cutting height and intensity of traffic/wear. The implications for ball bounce and foot stability playability arising from this data are not clear and further work is required to confirm the nature of these relationships.

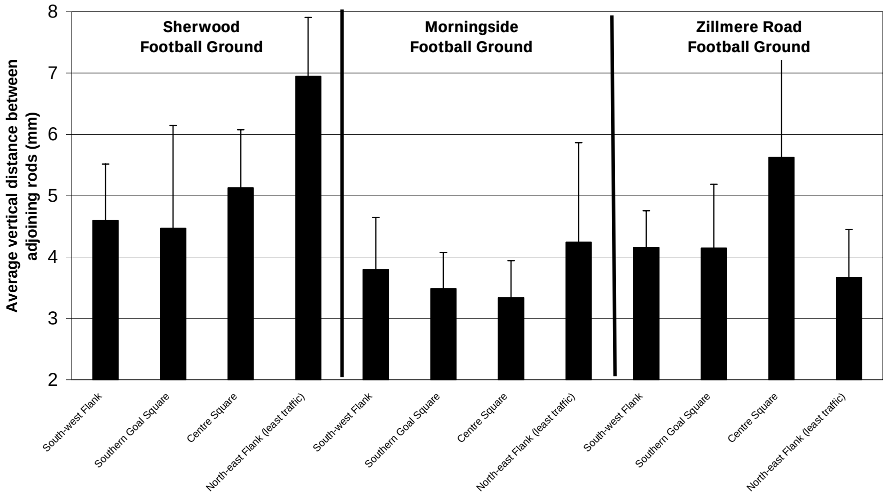



**Figure 10. Surface roughness on three sporting fields measured using a profilemeter with 30 mm rod spacings**

## Conclusions

The objective measurements undertaken in this characterisation study have confirmed that the soil profiles on the AFLQ Premier League sporting fields are highly variable. This suggests that care should be taken in extrapolating data from soil amendment and irrigation trials conducted at any one field to other sporting fields unless there is some understanding of the soil materials present at each site. The nature of the materials at each field site will need to be characterised and the development of amendment and management strategies should be targeted to address key constraints on each field. The range of different soil profiles encountered in different areas within the same field also suggests that the development of soil profile amendment and irrigation management strategies to improve the playability of these surfaces will also need to consider both the spatial and temporal variations in the soil material.

## References

McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J., Hopkins, M.S. (1990). Australian Soil and Land Survey. Field Handbook. Inkata Press, Melbourne.

Simunek, J., M. Sejna, and M. Th. van Genuchten (1999). The HYDRUS-2D software package for simulating two-dimensional movement of water, heat, and multiple solutes in variably saturated media. Version 2.0, *IGWMC - TPS - 53,* International Ground Water Modeling Center, Colorado School of Mines, Golden, Colorado, 251pp.

# Appendix 1

## *Soil Profile Characterisation Sheets*

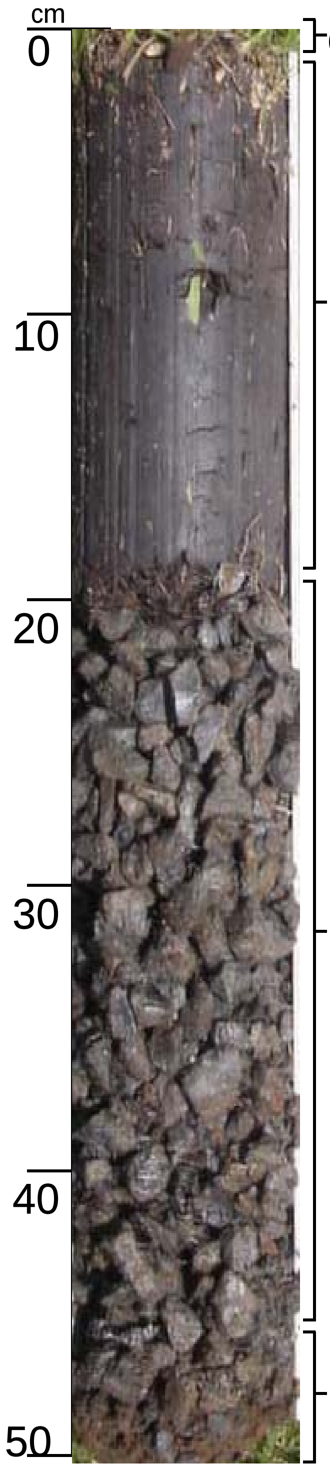
**Everton**
**Sherwood**
**Zillmere**
**Morningside**

Average turf cover

# Everton

Centre square area
Intermediate-High Wear

## Soil profile description

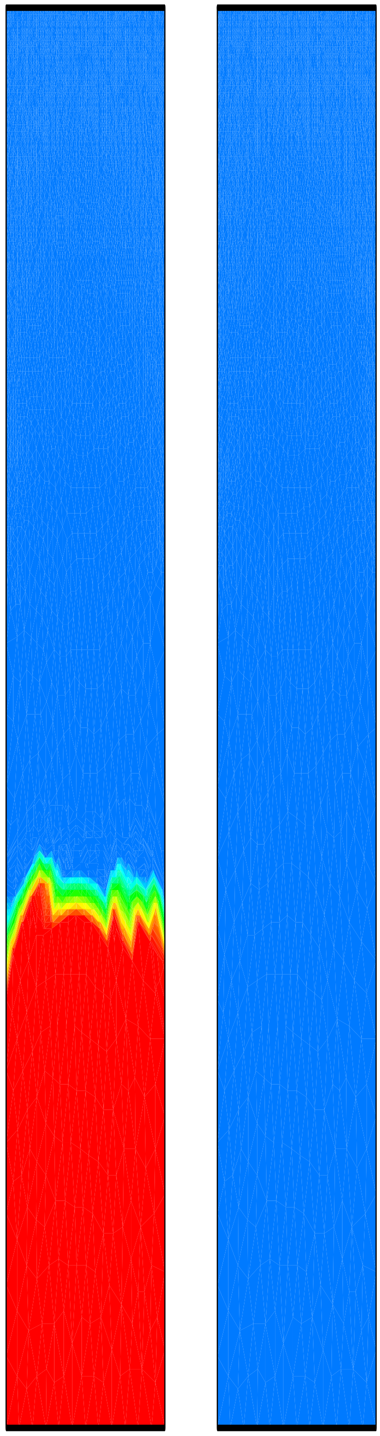


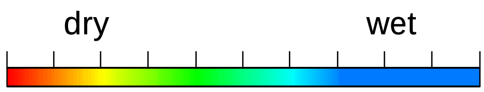

| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—19 | black, heavy clay; pH 7 |
| 19—45 | dark grey gravel (10-20mm subangular); pH 7 |
| 45—50 | dark brown, sandy clay loam; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|



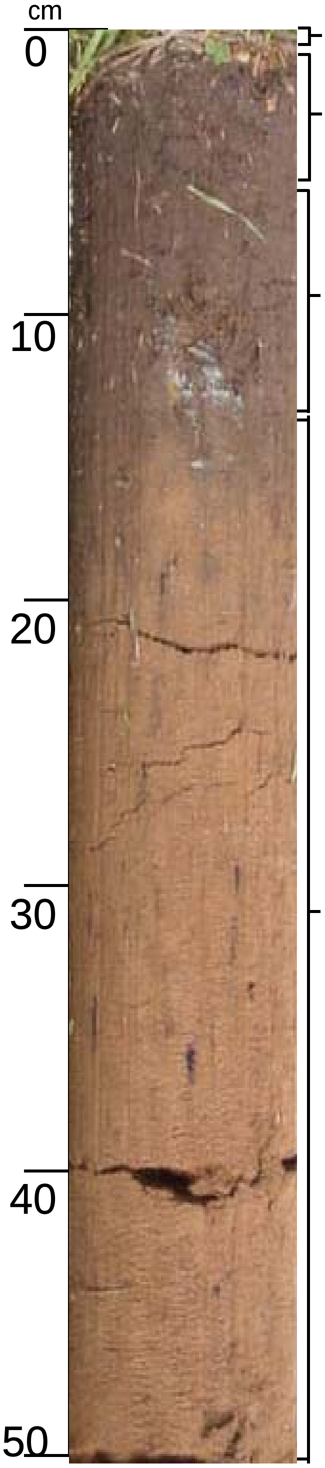


# Everton

North-east flank
Low Wear

Average turf cover

## Soil profile description

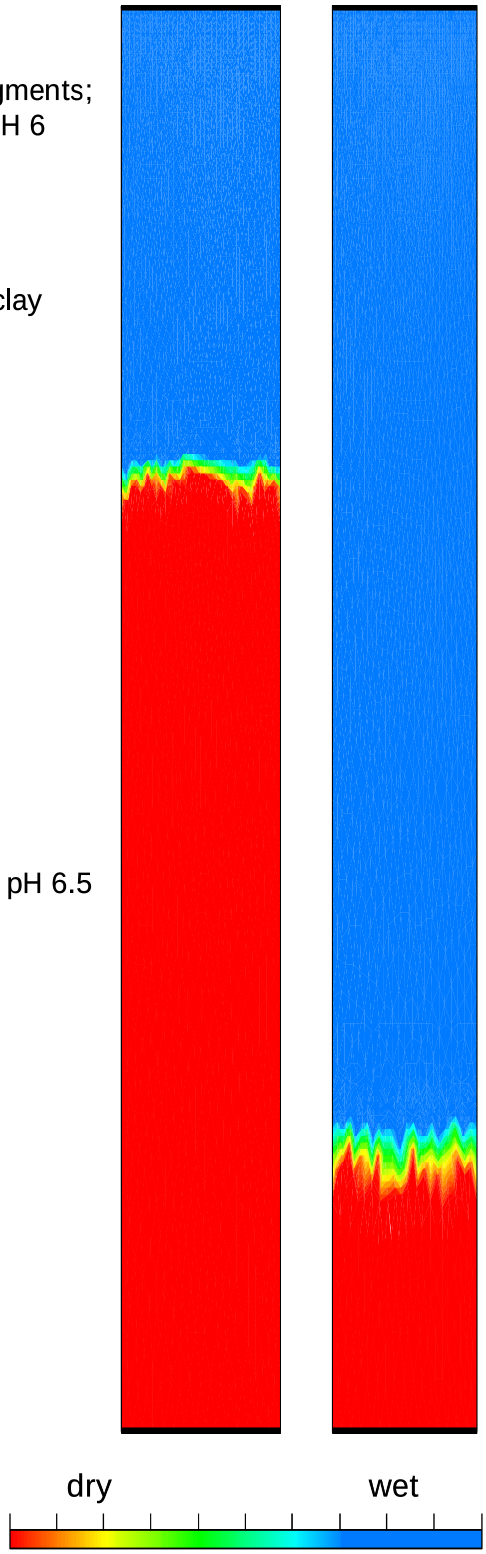



| Depth (cm) | Description |
|---|---|
| 0—1 | thatch |
| 1—5 | 5% 2-5mm subangular coarse fragments; very dark grey, sandy clay loam; pH 6 |
| 5—12.5 | 5% 10-20mm subangular coarse fragments; very dark grey, sandy clay loam; pH 6 |
| 12.5—50 | dark yellowish brown, sandy loam; pH 6.5 (thick roots leaving the bottom of the profile) |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

25mm in 24 hours | 60mm in 3 days



Average turf cover

# Everton

Southern goal square
High wear

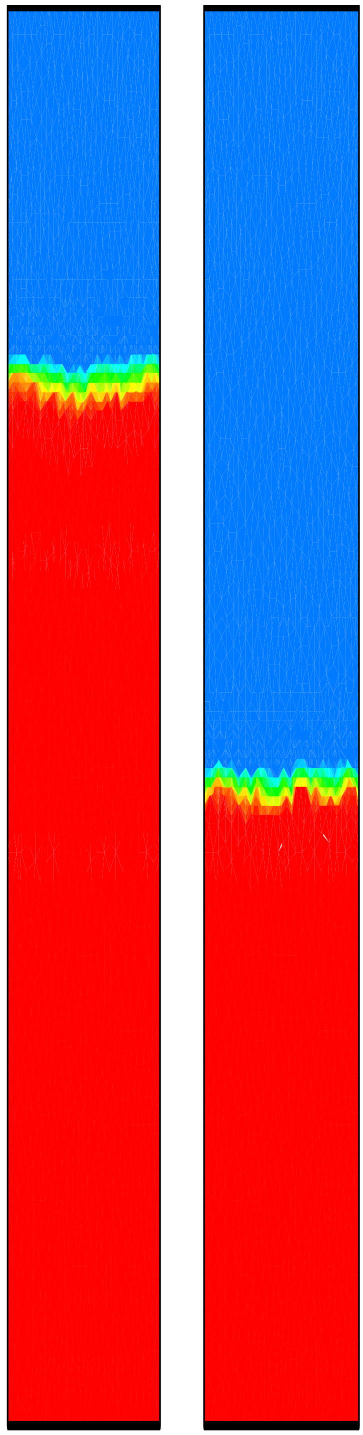
## Soil profile description

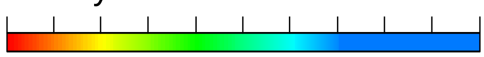

| Depth (cm) | Description |
|---|---|
| 0—1 | thatch |
| 1—7 | 15% 15+ mm subangular coarse fragments; 5% 2-5mm subangular coarse fragments; dark brown, sandy clay loam; pH 5.5 |
| 7—19 | dark brown, silty loam; pH 6.5 |
| 19—29.5 | dark yellowish brown, loam; pH 6.5 |
| 29.5—50 | yellowish red, loam; pH 7; (thick roots leaving the bottom of the profile) |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|



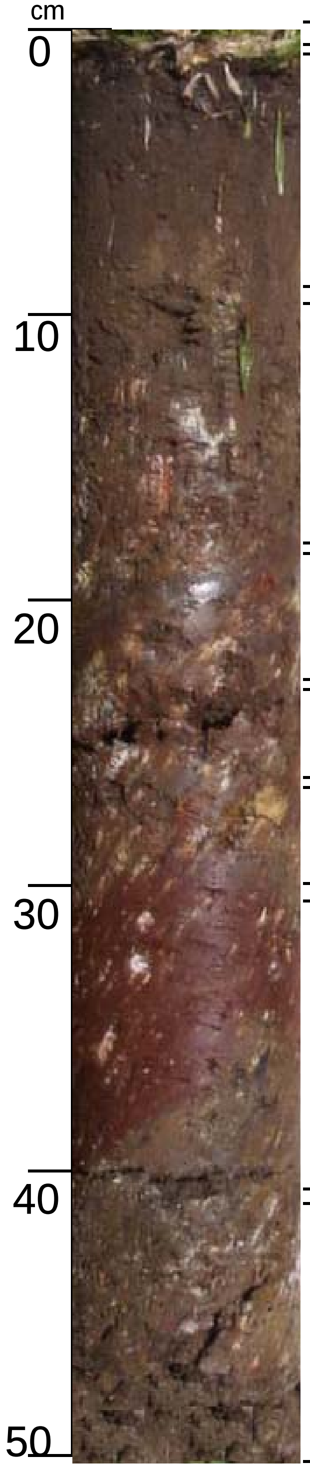


Average turf cover

# Everton

South-west flank
intermediate wear

## Soil profile description

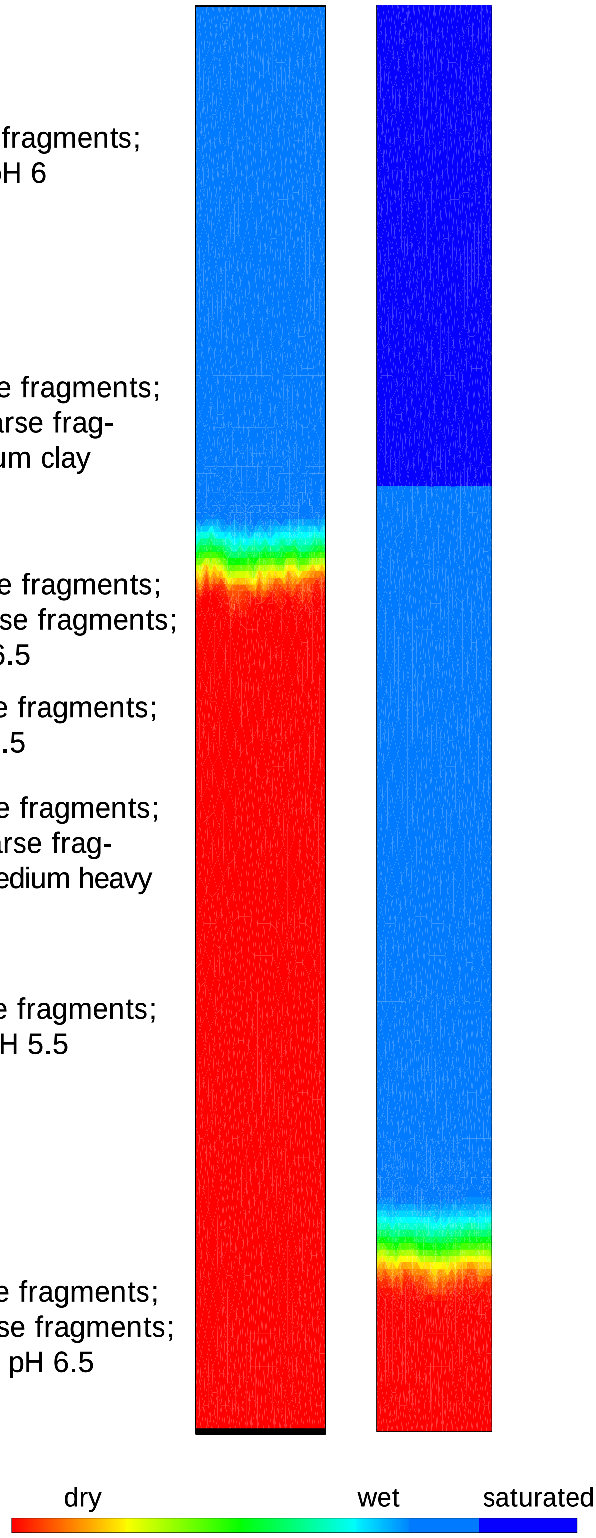



| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—9 | 5% 2-5 mm subangular coarse fragments; olive brown, sandy clay loam; pH 6 |
| 9—17.5 | 25% 2-5 mm subangular coarse fragments; 10% 15-20 mm subangular coarse fragments; dark olive brown, medium clay (sandy); pH 6.5 |
| 17.5—22 | 15% 2-5 mm subangular coarse fragments; 15% 5-10 mm subangular coarse fragments; dark brown; medium clay; pH 6.5 |
| 22—25.5 | 35% 2-5 mm subangular coarse fragments; dark brown, medium clay; pH 6.5 |
| 25.5—31 | 30% 2-8 mm subangular coarse fragments; 20% 15-20 mm subangular coarse fragments; dark yellowish brown, medium heavy clay; pH 6.5 |
| 31—41 | 15% 2-8 mm subangular coarse fragments; very dusky red, medium clay; pH 5.5 |
| 41—50 | 20% 2-5 mm subangular coarse fragments; 5% 10-20 mm subangular coarse fragments; light olive brown, medium clay; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

25mm in 24 hours | 60mm in 3 days



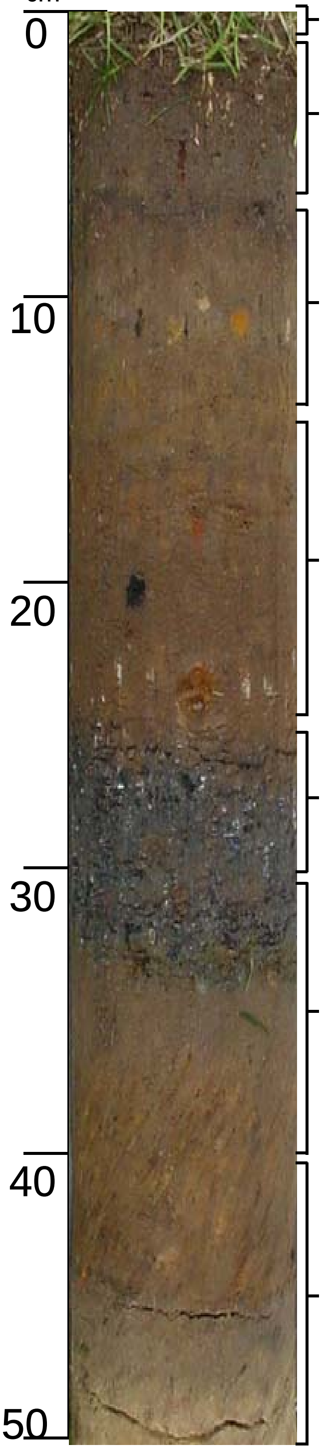
# Sherwood

North-east flank

Low Wear

Average turf cover

## Soil profile description



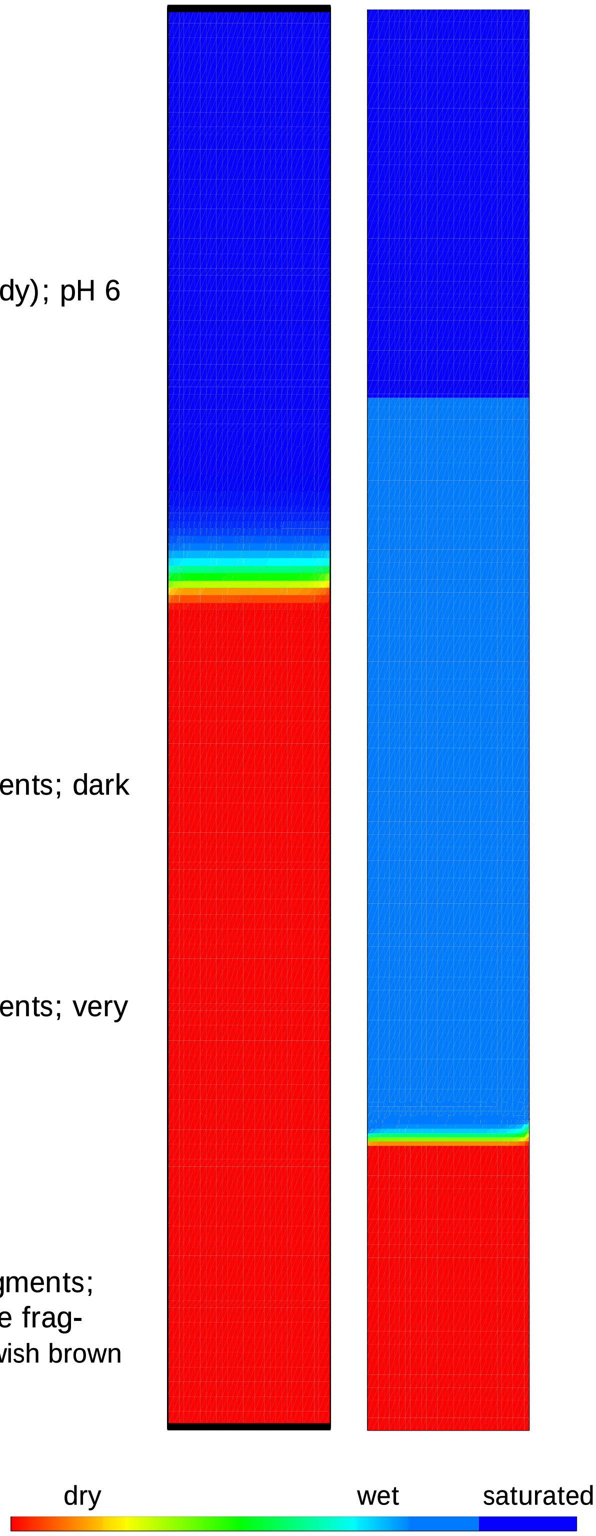

Picture of core no. 1 from same location

| Depth (cm) | Description |
|---|---|
| 0—1.3 | thatch |
| 1.3—6 | dark brown, sandy loam; pH 6 |
| 6—14 | dark grey, light medium clay (sandy); pH 6 |
| 14—24 | dark brown, light clay; pH 5.5 |
| 24—30 | 50% 3-5 mm round coarse fragments; dark grey, loamy sand; pH 5.5 |
| 30—40 | 25% 3-5 mm round coarse fragments; very dark grey, sandy loam; pH 6 |
| 40—50 | 20% 2-3 mm rounded coarse fragments; 15% 10-15 mm subangular coarse fragments; very dark grey (20% yellowish brown mottles), loamy sand; pH 6 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|

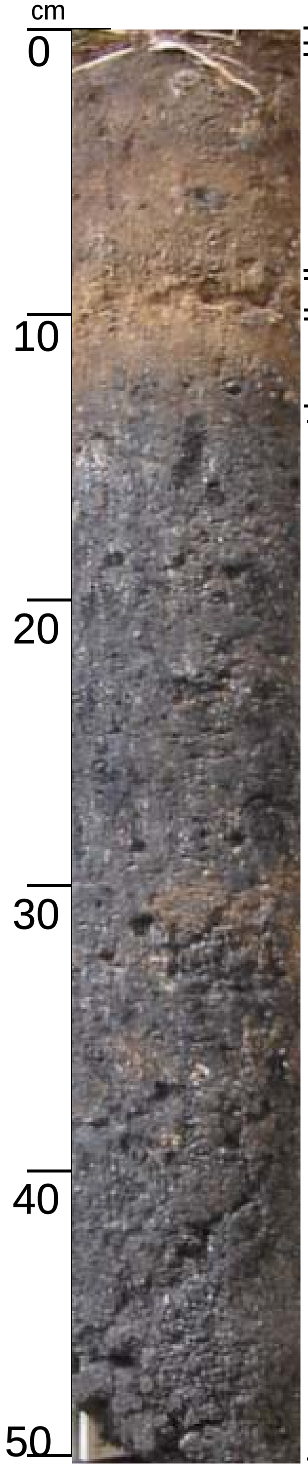


Average turf cover

# Sherwood

South-west flank
intermediate wear

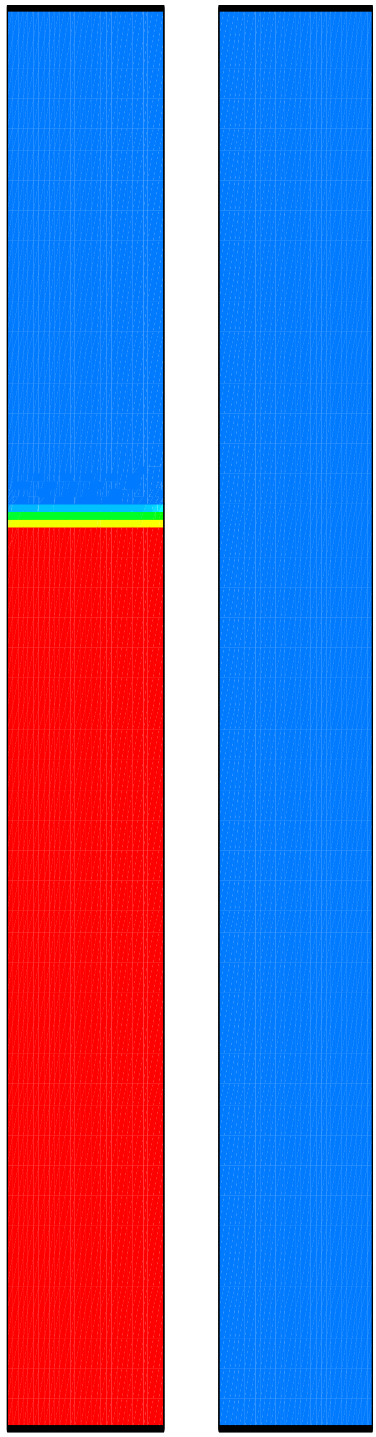
## Soil profile description

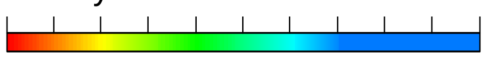



| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—8 | 5% 2-3 mm round coarse fragments; dark brown, sandy loam; pH 5.5 |
| 8—10 | 15% 3-5 mm subangular coarse fragments; dark yellowish brown, sand; pH 6 |
| 10—13 | 5% 2-3 mm subangular coarse fragments; dark brown, light clay (with |
| 13—50 | 25% 10-15 mm subangular coarse fragments; 25% 2-3 mm subangular coarse fragments; very dark grey, sand (with grit), pH 7 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)



Average turf cover

# Sherwood

Southern goal square

High wear

## Soil profile descriptio

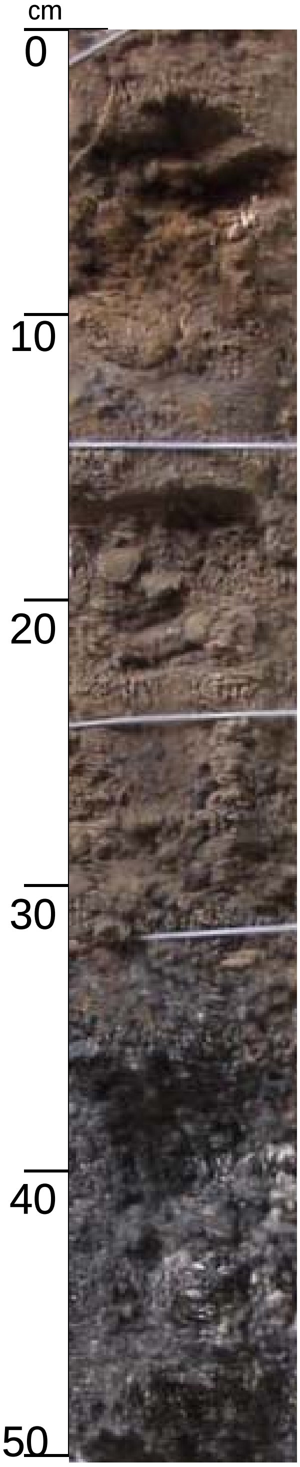


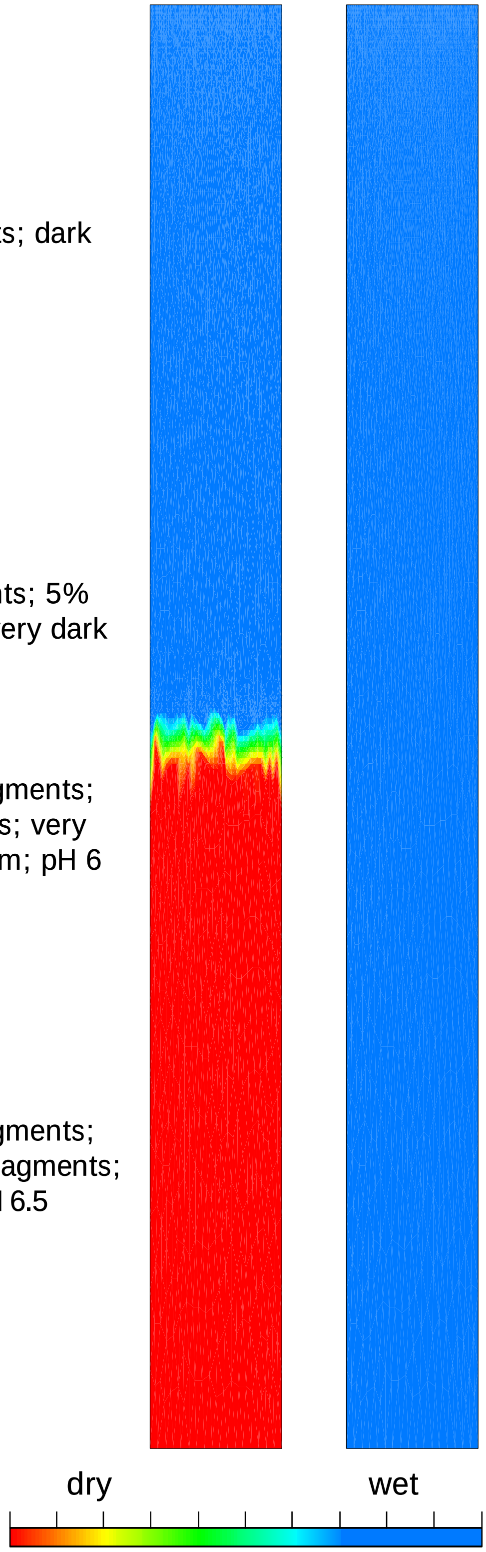

photo taken after horizon sampling, soil layers above bottom sand layer might vary significantly

| Depth (cm) | Description |
|---|---|
| 0—0.8 | greyish brown, loamy sand; pH 6 |
| 0.8—17 | 5% 10 mm round coarse fragments; dark brown, light clay(with sand); pH 6 |
| 17—25 | 15% 10 mm round coarse fragments; 5% 3-5 mm round coarse fragments; very dark greyish brown, sandy loam; pH 6 |
| 25—30 | 10% 15mm subangular coarse fragments; 5% 3-5mm round coarse fragments; very dark greyish brown, sandy clay loam; pH 6 |
| 30—50 | 20% 20mm subangular coarse fragments; 30% 5-10mm subangular coarse fragments; very dark grey, sand (with grit), pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|

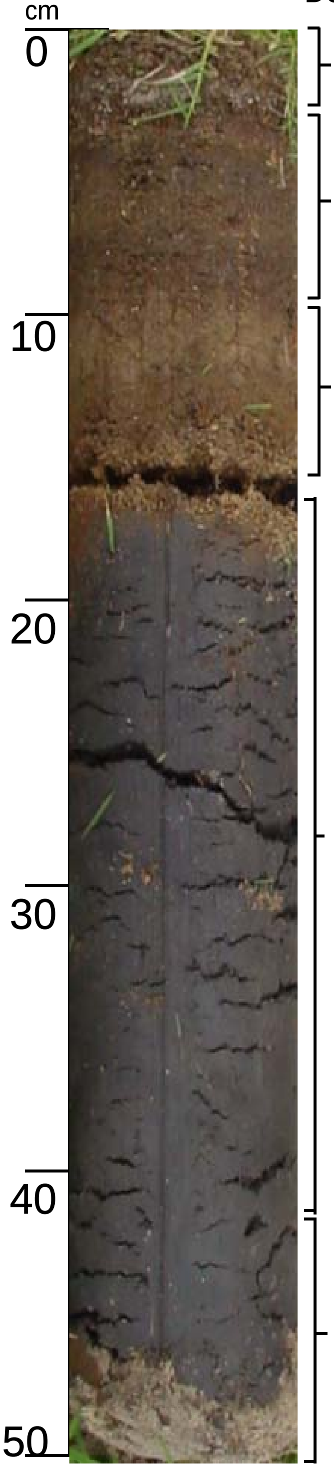


Average turf cover

# Sherwood

Centre square area
Intermediate-High Wear

## Soil profile description

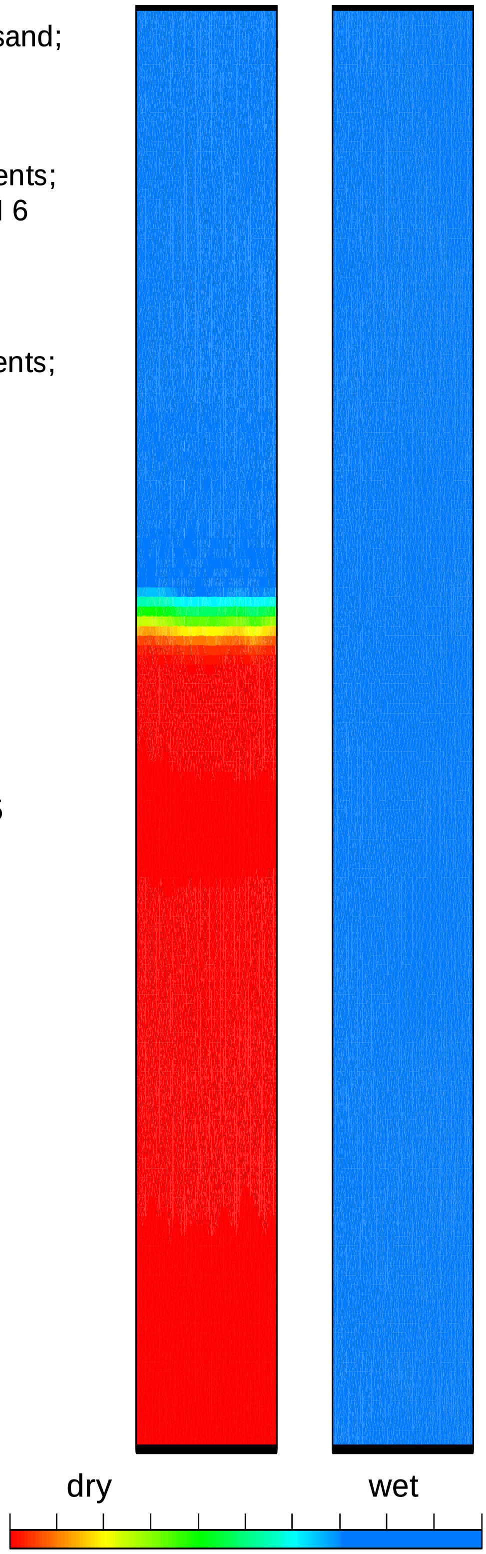



| Depth (cm) | Description |
|---|---|
| 0—3 | very dark greyish brown, loamy sand; pH 5.5 |
| 3—9 | 5% 2-3 mm round coarse fragments; dark brown; sandy clay loam; pH 6 |
| 9—15 | 5% 2-3 mm round coarse fragments; dark brown, sandy loam; pH 6 |
| 15—41 | black. medium heavy clay; pH 6.5 |
| 41—50 | light brownish grey, sand; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

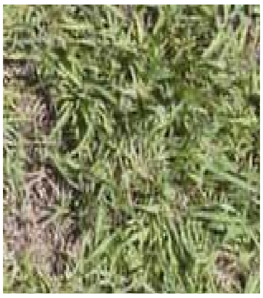
25mm in 24 hours | 60mm in 3 days



# Zillmere

North-east flank
Low Wear

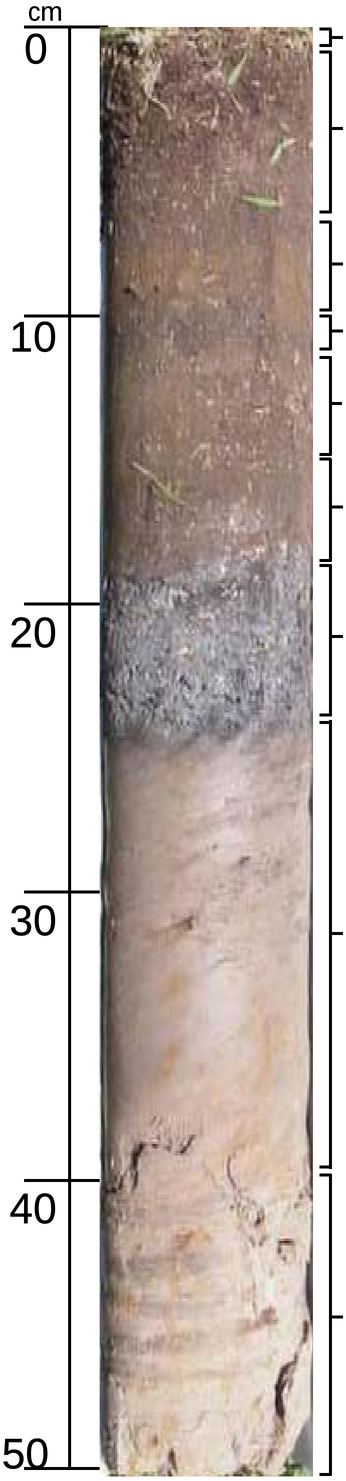
Average turf cover



wetting characteristics (estimated)

Initial conditions: very dry (-100m)

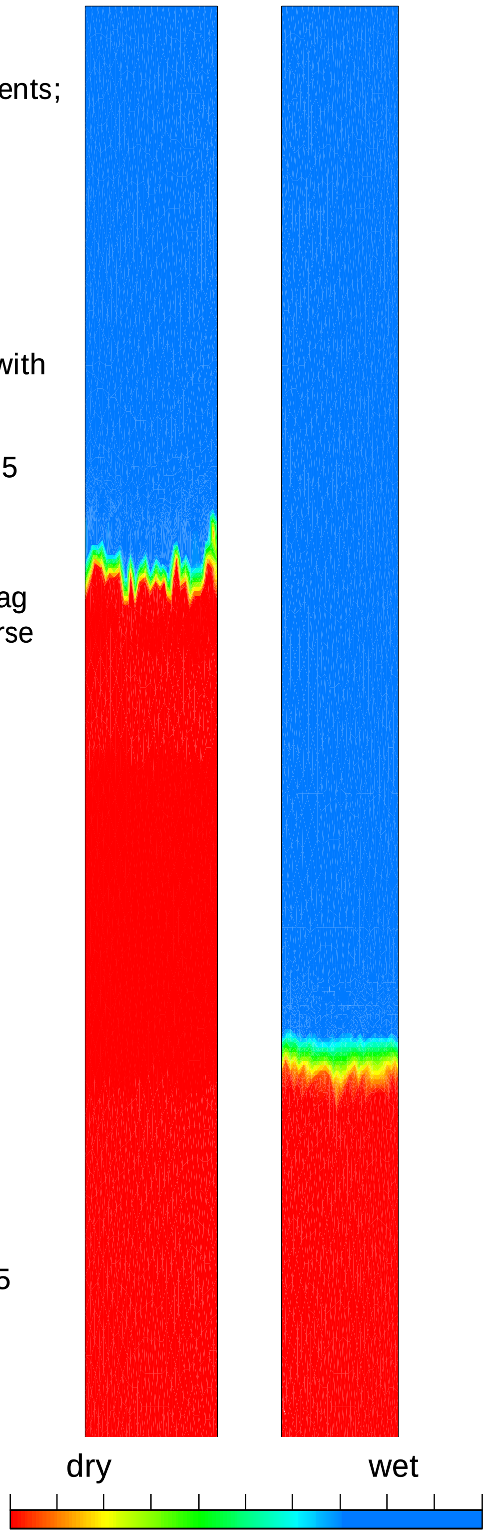
## Soil profile description




| Depth (cm) | Description |
|---|---|
| 0—1 | thatch |
| 1—6 | 5% 2-5mm subangular coarse fragments; black, clayey sand; pH 5 |
| 6—9 | dark brown, sandy loam; pH 6 |
| 9—11 | dark brown, sandy clay loam; pH 6.5 |
| 11—14 | very dark greyish brown, clay loam (with sand); pH 7.5 |
| 14—18 | very dark brown, medium clay; pH 7.5 |
| 18—23.5 | 30% 10-20 mm subangular coarse frag ments; 20% 2-5 mm subangular coarse fragments; black, sand; pH 7.5 |
| 23.5—40 | very dark greyish brown, silty clay loam; pH 8 |
| 40—50 | dark greyish brown, light clay; pH 7.5 |

25mm in 24 hours

60mm in 3 days



Average turf cover

# Zillmere

Centre square area
Intermediate-High Wear

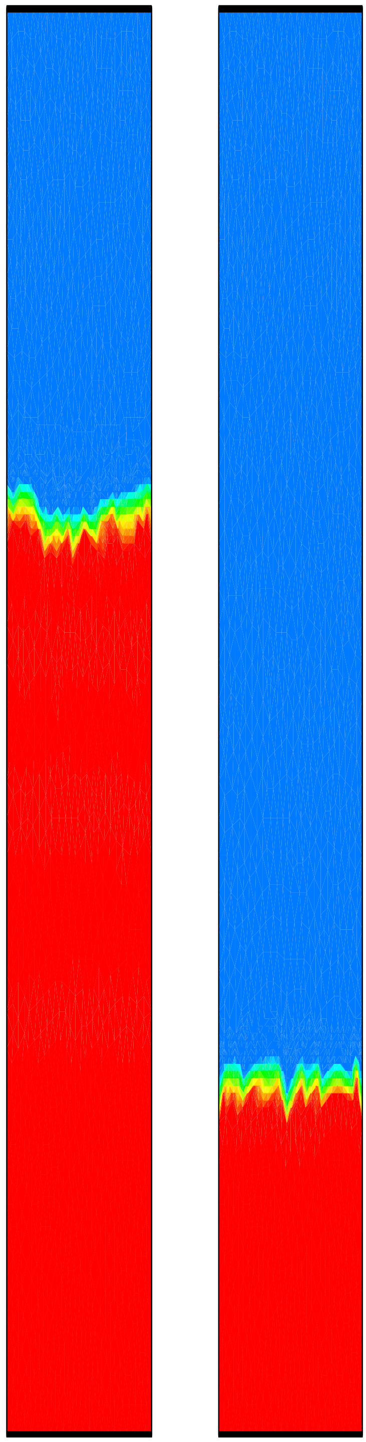
## Soil profile description


| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—6.5 | dark brown, sandy loam; pH 7 |
| 6.5—10 | dark grey, sandy loam; pH 7 |
| 10—14 | 5% 2-5 mm subangular coarse frag- ments; dark greyish brown, loamy sand; pH |
| 14—23 | dark yellowish brown, sandy loam; pH 7.5 |
| 23—28 | very dark brown, medium clay; pH 8.5 |
| 28—36 | 20% 2-5 mm subangular coarse frag- ments; 20% 5-10 mm subangular coarse fragments; black, sand; pH 8 |
| 36—50 | dark greyish brown (15% brown mottles), sandy clay loam; pH 7.5 |

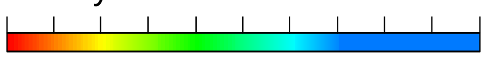
wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|



dry wet

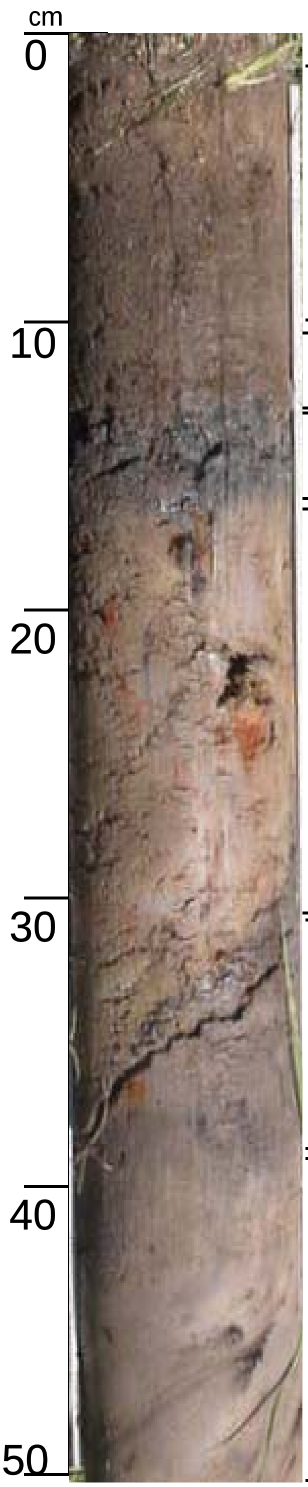


# Zillmere

Southern goal square
High wear

Average turf cover

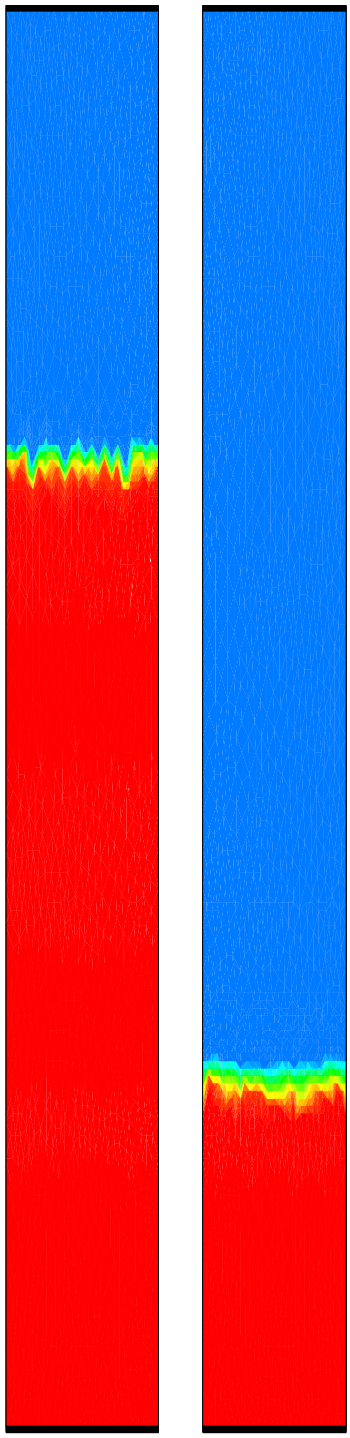
## Soil profile description

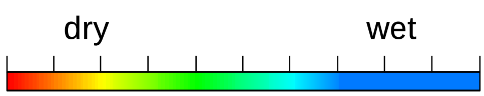



| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—9 | dark olive brown, sandy clay loam; pH 6.5 |
| 9—13 | dark brown, silty clay loam; pH 7 |
| 13—16 | 40% 2-5mm subangular coarse fragments; black, sand (with grit); pH 6.5 |
| 16—31 | 10% shredded bricks, red, rounded; dark olive grey, medium heavy clay; pH 7.5 |
| 31—39.5 | very dark greyish brown, medium clay; pH 7 |
| 39.5—50 | greyish brown, sandy clay loam; pH 7 |

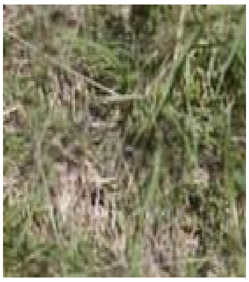
wetting characteristics (estimated)

Initial conditions: very dry (-100m)



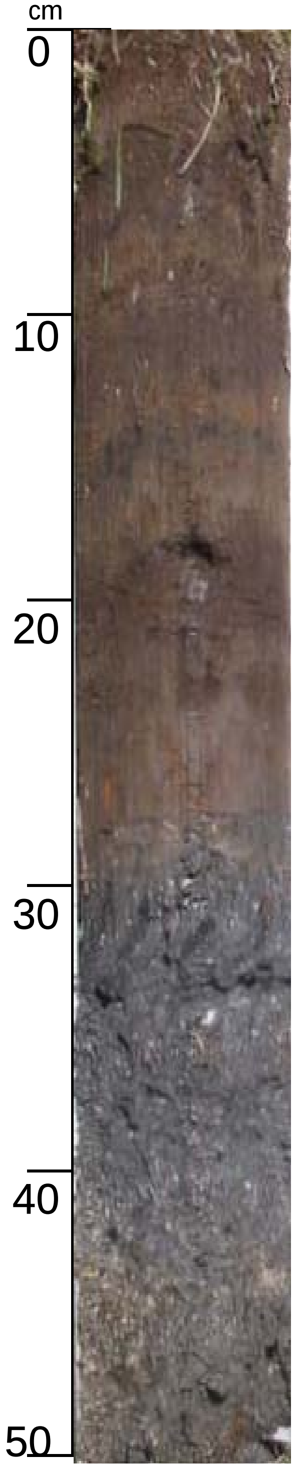
Average turf cover



# Zillmere

South-west flank
intermediate wear

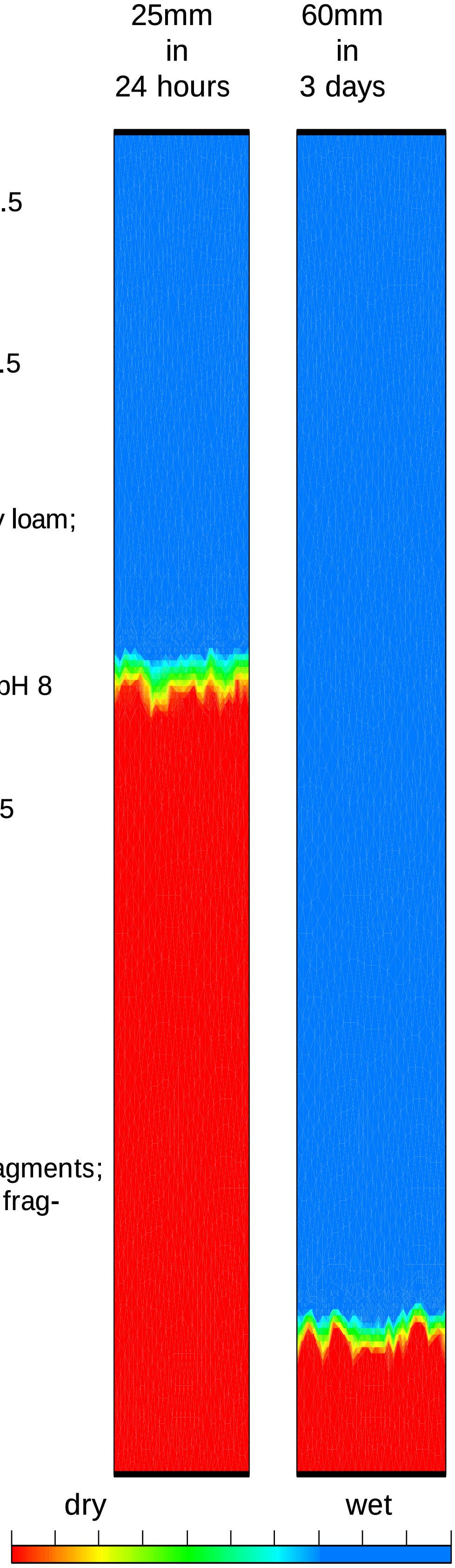
## Soil profile description




| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—5 | very dark brown, loamy sand; pH 6.5 |
| 5—7 | dark olive brown, sand; pH 7.5 |
| 7—10 | dark olive brown, sandy loam; pH 7.5 |
| 10—19 | very dark greyish brown, sandy clay loam; pH 7.5 |
| 19—23 | very dark brown, clay loam sandy; pH 8 |
| 23—29 | very dark grey, medium clay; pH 7.5 |
| 29—50 | 30% 2-5 mm subangular coarse fragments; 20% 10-25 mm subangular coarse fragments; black, sand; pH 6 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)



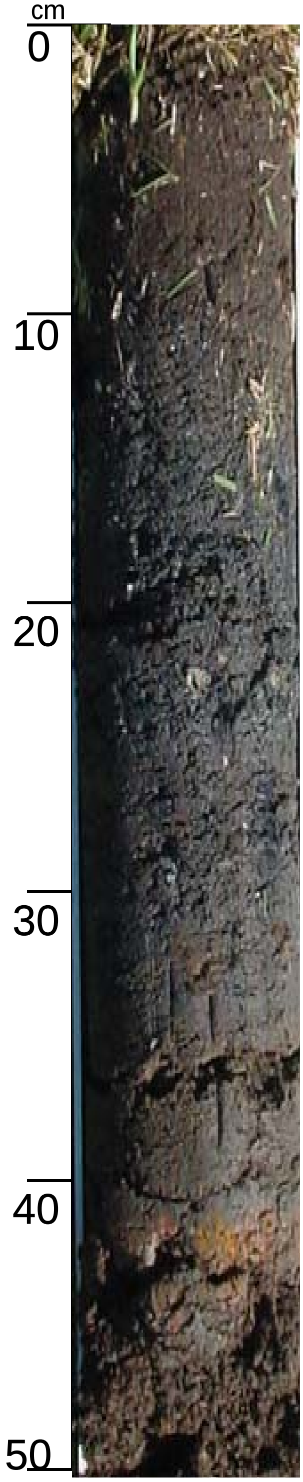
# Morningside

North-east flank

Low Wear

average turf cover

## Soil profile description

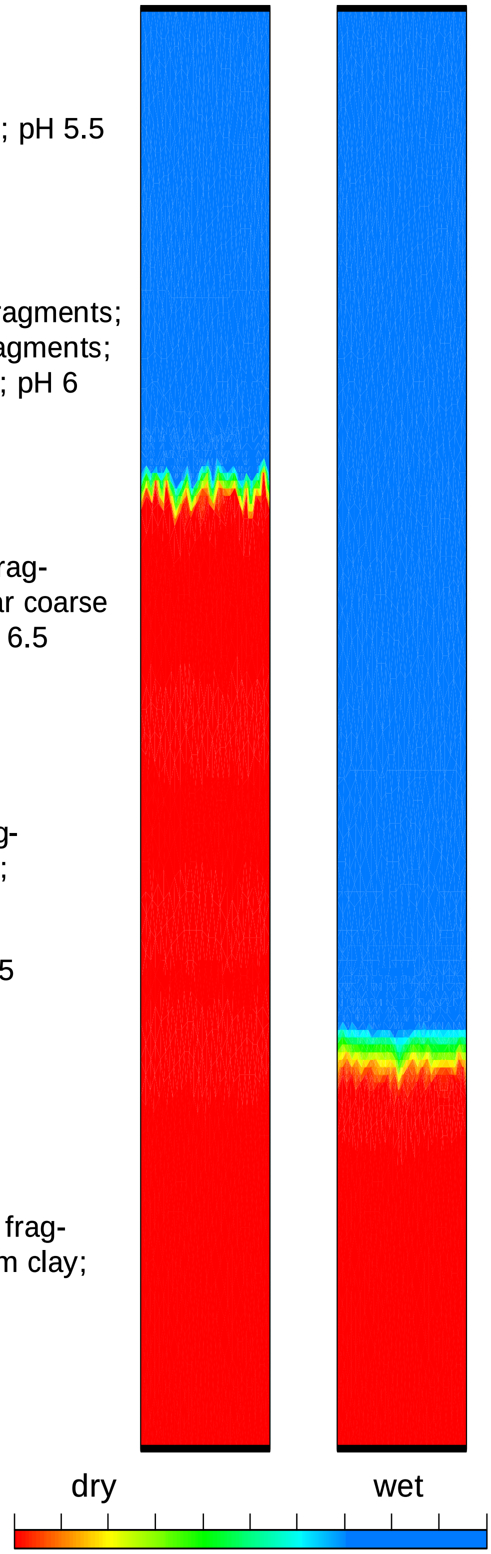



| Depth (cm) | Description |
|---|---|
| 0—1 | thatch |
| 1—9 | very dark brown, sandy clay loam; pH 5.5 |
| 9—14 | 5% 15+ mm subangular coarse fragments; 5% 2-5 mm subangular coarse fragments; very dark brown, clay loam sandy; pH 6 |
| 14—25 | 25% 2-5 mm subangular coarse fragments; 15% 15-30 mm subangular coarse fragments; black, sandy loam; pH 6.5 |
| 25—32 | 15% 2-10 mm subangular coarse fragments; black, clay loam (with sand); pH 7 |
| 32—36 | dark brown, silty clay loam; pH 6.5 |
| 36—50 | 5% 10-20 mm subangular coarse fragments; yellowish red, light medium clay; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|



# Morningside

Centre square area

Intermediate-High Wear

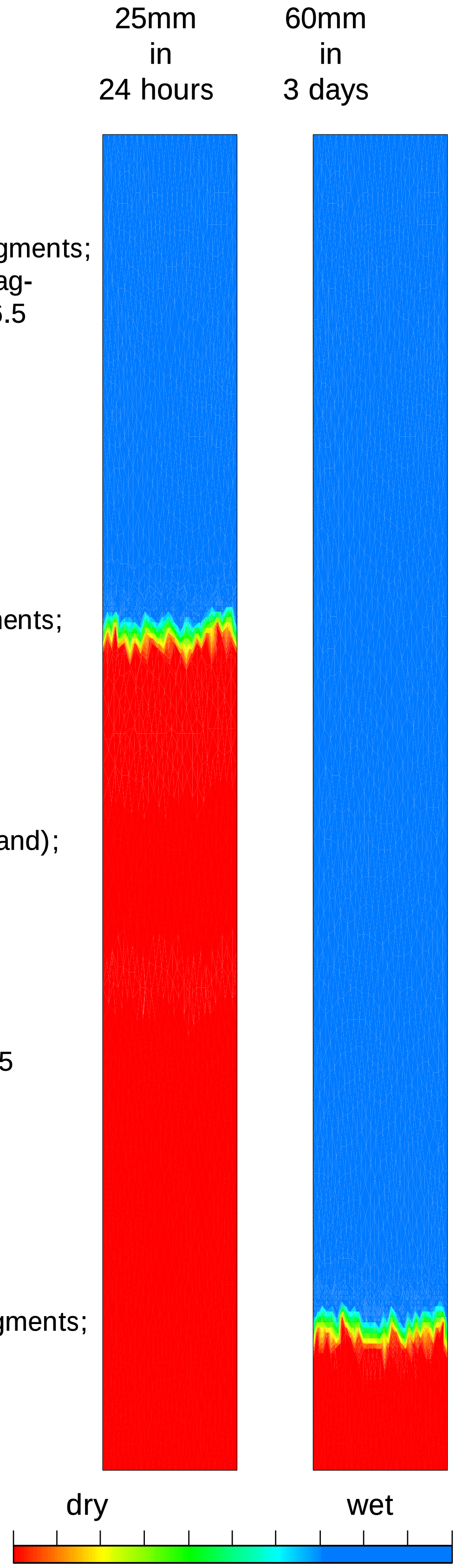
average turf cover

## Soil profile description


| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—9 | 10% 2-5 mm subangular coarse fragments; 10% 5-10 mm subangular coarse fragments; black, sandy clay loam; pH 6.5 |
| 9—17 | very dark brown, clayey sand; pH 6 |
| 17—21 | 5% 2-5mm subangular coarse fragments; black, loamy sand; pH 6.5 |
| 21—23 | black, medium clay; pH 6.5 |
| 23—31 | greyish brown, medium clay (with sand); pH 6.5 |
| 31—40 | light olive brown, loamy sand; pH 6.5 |
| 40—50 | 50% 2-5 mm subangular coarse fragments; yellowish brown, sand; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)



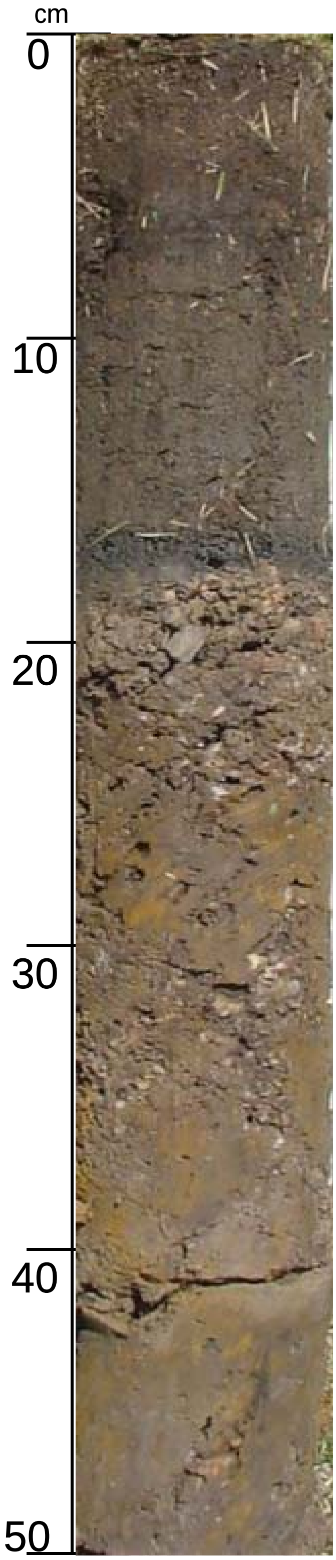
# Morningside

Southern goal square

High wear

average turf cover

## Soil profile description

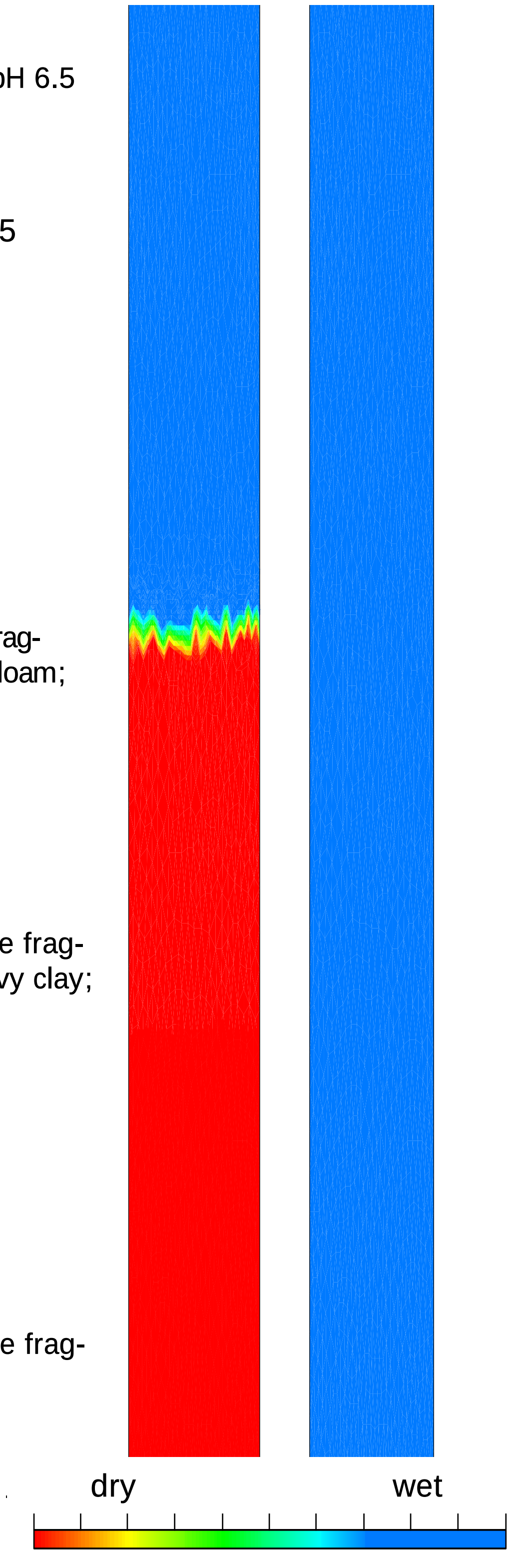



| Depth (cm) | Description |
|---|---|
| 0—0.2 | thatch |
| 0.2—7 | very dark brown, clayey sand; pH 6.5 |
| 7—10 | black, sandy clay loam; pH 6.5 |
| 10—21 | dusky red, sandy loam; pH 7.5 |
| 21—23 | 15% 5-10 mm subangular coarse fragments; reddish black, sandy clay loam; pH 8.5 |
| 23—41 | 20% 5-10 mm subangular coarse fragments; dark greyish brown, heavy clay; pH 8 |
| 41—50 | 30% 5-10 mm subangular coarse fragments; brown, heavy clay; pH 7 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

| 25mm in 24 hours | 60mm in 3 days |
|---|---|

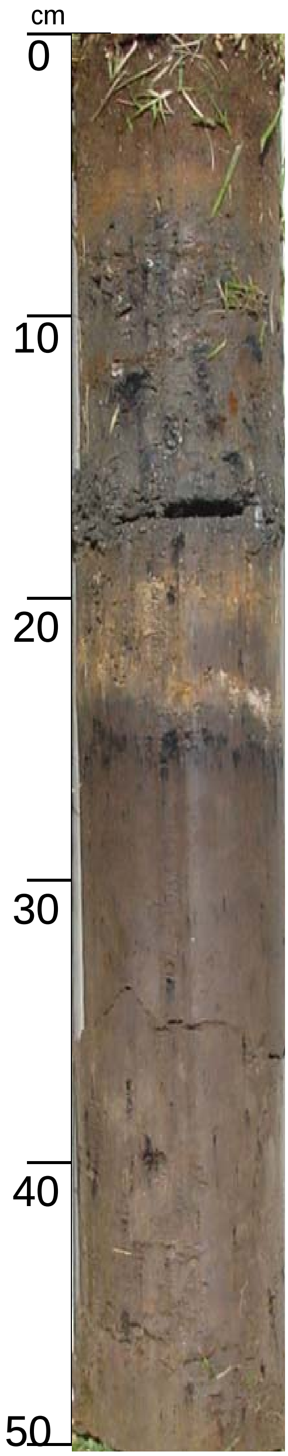


# Morningside

South-west flank
intermediate wear

average turf cover

## Soil profile description




Picture of core no. 1 from same location

| Depth (cm) | Description |
|---|---|
| 0—0.5 | thatch |
| 0.5—2 | very dark brown, clayey sand; pH 6 |
| 2—4 | very dark brown, loamy sand; pH 6 |
| 4—9 | 10% 5-10 mm subangular coarse fragments; very dark brown, sandy clay loam; pH 6 |
| 9—21 | 20% 10-15 mm subangular coarse fragments; 20% 5-10 mm subangular coarse fragments; black, sandy clay loam; pH 6 |
| 21—35 | 5% 15-20 mm subangular coarse fragments; 2% 3-5 mm rounded coarse fragments; black, light clay; pH 6 |
| 35—50 | black, light medium clay; pH 6.5 |

wetting characteristics (estimated)

Initial conditions: very dry (-100m)

25mm in 24 hours | 60mm in 3 days